Business Intelligence and Analytics Education: Hermeneutic Literature Review and Future Directions in IS Education

Emergent Research Forum Papers

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Abstract

Interest in business intelligence and analytics education has begun to attract IS scholars' attention. In order to discover new research questions, there is a need for conducting a literature review of extant studies on BI&A education. This study identified 44 research papers through using Google Scholar related to BI&A education. This research contributes to the field of BI&A education by (a) categorizing the existing studies on BI&A education into the key five research foci, and (b) identifying the research gaps and providing the guide for future BI&A and IS research.

Keywords

Business intelligence & Analytics education, literature review

Introduction

Business intelligence and analytics (BI&A) is crucial for organizations seeking to extract business insights from a very large set of highly variable data. In general, BI&A can be regarded as the practice of methodical exploration of an organizations’ data with emphasis on statistical analysis that helps companies make data-driven decisions (Acito and Khatri, 2014; Hopkins, 2010). Data-savvy professionals play a pivotal role in obtaining the power of business analytics. However, research by the McKinsey Global Institute (MGI) reported that by 2018, the United States alone may face a shortage of 140,000 to 190,000 business analytics professionals as well as 1.5 million data-savvy managers who could take advantage of big data to make effective decisions (Manyika et al., 2011). Such a shortage of talent has become a serious barrier of firm prosperity for some industries (Davenport & Patil, 2012).

To fill up this growing need, over 130 academic programs have offered undergraduate and graduate degrees in Business Analytics or Data Science since 2007 (Wixom et al., 2014). Due to the multidisciplinary nature of BI&A, business analytics programs integrate information systems (IS) disciplines into BI&A curriculum to offer a sequence of interdisciplinary courses that allow students to learn data analysis and IS-related skills. However, most business analytics programs in the College of Business are in their infancy and lack the commonly accepted model of business analytics curriculum as well as appropriate pedagogical design for developing student professional skills (Wilder & Ozgur, 2015; Chiang et al., 2012). Even in practice, the ambiguity on job description and skill requirement makes hiring the right kind of data scientist a challenge. This has resulted in 64% of organizations in the United States failing to meet all of their expected analyzing data skills needed in the workplace according to American Management Association's (2013) report.

In this regard, interest in BI&A education has begun to attract IS scholars’ attention. Two panel discussions on BI&A connected to IS education were held in the leading IS conferences in 2014 (Schiller et al., 2014; Agarwal et al., 2014) and has generated some literature on the topic. In order to discover new research questions, there is a need for conducting a hermeneutic literature review of extant studies on BI&A education. With this rigorous review, our research contributes to the field of BI&A education by (a) categorizing the existing studies on BI&A education into the key five research foci, and (b) identifying the research gaps and providing the guide for future BI&A and IS research.
Research Method

I conducted a review on BI&A existing studies by following the Boell and Cecez-Kecmanovic (2014)’s suggestions for literature review process. This literature review approach included the five process: (1) search and acquisition; (2) mapping and classifying; (3) critical assessment; (4) argument development; and (5) research problem/questions. In the search and acquisition, I identified relevant literature on business analytics education by using Google Scholar to search the BI&A education related keywords appearing in the title and focusing on the time period of 2009 through 2015. I asked that only papers with keywords appearing in the title be located. Table 1 shows the keyword search process and results. The search engine returned 568 results. Each of the 568 articles were reviewed by its title and abstract if necessary, but only those meeting the following criteria were considered for inclusion in this study: (1) published in the journals or conference proceedings (excluding the working paper series, lecture notes, books, practical reports, white papers, and abstract only); (2) a primary focus on BI&A education. This resulted in a reduced set of 26 papers.

In order to find the biggest share of relevant literature, I conducted snowballing and citation analysis that suggested by Boell and Cecez-Kecmanovic (2014) to identify further relevant literature after 26 relevant publications are identified. I examined these papers to handpick 18 additional papers met the criteria. Thus, our analysis here is based on a total of 26+18=44 papers in all, including 28 Journal papers and 16 conference proceeding papers, as listed in Appendix 1.

In the mapping and classifying and critical assessment processes, 44 papers are listed and categorized into five key research foci based on relevant ideas, findings and contributions to knowledge, along with a summary of their key findings, as shown in next section and Appendix 2. Based on the current knowledge generated in the existing literature, in the argument development, I construct research gaps, which provide the guideline for further research. In the final process, through argumentation future directions of research and the rationale for research questions are developed.

<table>
<thead>
<tr>
<th>Keyword search</th>
<th>Number of papers identified in search</th>
<th>Number of papers meeting inclusion criteria</th>
<th>After deleting duplicates</th>
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<tbody>
<tr>
<td>allintitle: Business analytics education</td>
<td>5</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>allintitle: Business analytics curriculum</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>allintitle: Business analytics</td>
<td>441</td>
<td>18</td>
<td>12</td>
</tr>
<tr>
<td>allintitle: Data scientist</td>
<td>65</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>allintitle: Chief data officer</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>allintitle: Business intelligence education</td>
<td>46</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>allintitle: Business intelligence curriculum</td>
<td>7</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>568</td>
<td>36</td>
<td>26</td>
</tr>
</tbody>
</table>

1 most articles in this search discuss issues pertaining to the application of business intelligence in the field of learning analytics

Table 1. Keyword Search and Results on the Topics of BI&A Education

Literature Review on BI&A Education

Based on a review of 44 research papers related to BI&A education, I categorized these papers into five key research foci based on their relevant ideas, findings and contributions. The five research foci are presented in the remainder of this section.

Research Focus 1: The Current State of BI&A Education

The first research focus discusses the current state of business analytics and intelligence education (e.g., Chiang et al., 2012; Davis and Woratschek, 2015; Sircar 2009; Wixom et al., 2011; Wixom et al., 2014). Through a survey investigation of business analytics faculties, students, and industry practitioners from 2009 to 2013, Wixom et al. (2014), indicate the growing industrial needs for business analytics professionals and report the BI&A course offerings, the academic alliance programs used to access BI&A resources, and students’ opinions for BI&A courses they attended. Davis and Woratschek (2015)
investigate various BI&A tools that are being used for the current and past undergraduate and graduate students, and then provide the recommendations for including specific BI&A software in the information systems curriculum. These studies present the overview of business analytics education from both practical and academic standpoints so as to provide a foundation for future research.

**Research Focus 2: The Role of Data-savvy Professional in Practice**

The second research focus introduces and defines the role of data-savvy professionals, such as data scientists and chief data officers (CDOs). Data scientists are defined as “the people who understand how to fish out answers to important business questions from today’s tsunami of unstructured information (Thomas et al., 2012, p.73).” Wixom et al. (2014) categorize business analytics professionals as business intelligent (BI) generalists who can apply general BI concepts and techniques to functional areas and BI specialists who can generate creative BI solutions across disciplines. By definition, a data scientist is a hybrid role that requires a broad combination of technical and business skills and multidisciplinary knowledge domains.

In addition, this research focus also emphasizes the importance of these roles in creating a big-data enabled enterprise (e.g., Davenport and Patil 2012; Lee et al., 2014; van der Aalst 2014). For example, Davenport and Patil (2012) delineate the current status of the job market and job tasks for the data scientists as well as provide the guideline of finding the data scientists that fit the company needs. Lee et al. (2014) illustrate the roles of CDO through a three-dimensional cubic framework. This framework identifies eight different CDO role profiles and describes the focus of the CDO’s engagement (inwards vs. outwards), the preference of data acquisition (traditional data vs. big data), and value impact (service vs. strategy) for each role of CDO. These studies describe the roles and responsibilities of data-savvy professionals. This helps organizations strategize the establishment of their CDOs and data scientists as well as help education institutions understand the emergence needs for business analytics professionals.

**Research Focus 3: The Design and Development of BI&A Curriculum**

The third research focus shares benchmarking experiences from several business analytics’ academic programs and proposes the frameworks of business analytics programs’ design and curriculum development at the undergraduate and graduate levels (e.g., Al-Sakran 2014; Andoh-Baidoo et al., 2014; Chiang et al., 2012; Gorman and Klimberg 2014; Wilder and Ozgur 2015). By reviewing the 50 business analytics programs in the United States, studies such as Gorman and Kimberg (2014), Wilder and Ozgur (2015) and Sircar (2009) have provided the overview and current status of business analytics curriculums and suggestions for the improvements on course offerings. For instance, Wilder and Ozgur (2015) advocate that BA programs should integrate some important managerial courses that aim to train students’ problem solving and critical thinking skills into their curricula rather than merely focusing on statistics courses (e.g., Business Statistics, Calculus, and Predictive Modeling). In addition to reviewing the BA curricula, these studies have addressed implementation guidelines to build a “dream (not just big)” BA program. Specifically, I summarize a successful BA program can be built by the following five factors:

- Developing new interdisciplinary courses by collaborating with other departments or industries
- Aligning BA course offerings with the needs of practice
- Considering using the real-world projects that allow students to work with industrial professionals and learning how to define the problems, collect, organize, analyze, and visualize data
- Capturing the union of statistics, quantitative methods in the field of operation research, and management information systems in an ingenious BA curriculum
- Strengthening the faculty members’ expertise on business analytics and intelligence

**Research Focus 4: Teaching Cases and Learning Activities for BI&A**

The fifth research focus demonstrates the teaching cases and pedagogies for learning business analytics related courses (e.g., Edgington 2011; Pomykalski 2014; Presthus and Bygstad 2012) and discusses how to engage students in business analytics learning activities (e.g., Marjanovic 2011; 2012; Mrdalj and Diallo, 2010). For example, drawing on problem-based and puzzle-based learning, Presthus and Bygstad (2012) develop four puzzles with real life problems, providing data and solutions to teach students about managerial skills (e.g., problem identification and decision making) and technical skills (e.g., data mining and text mining). They also report that 71% of the students found all of the real life puzzles to be fun and helpful for their learning. In addition, Marjanovic (2012) adopts the revised Bloom’s taxonomy framework
to design two BI&A learning activities that aim to help students think about the problems as a business executive and take appropriate actions in response of changing business environments. These studies contribute to the effective practices and theories of teaching BI&A.

**Research Focus 5: Skill Sets and Knowledge Domains of BI&A Professionals**

The final research focus explores the skill sets and knowledge domains for business analytics professionals (e.g., Chiang et al., 2012; Li et al., 2014; Hosack and Sagers 2015). To identify the skill sets expected for business professionals, Momonov et al. (2015) conduct a search of companies’ open position announcements, while Wixom et al. (2014) conduct a survey of practitioners and find that foundational skills such as communication, SQL, and basic analytics remain most critical. In general, these studies have indicated that a qualified business analytics professional should have analytical skills, technical skills regarding data management and programming, and foundational business skills. I compared skill sets for BI&A professionals across four versions, as shown in Appendix 3. In addition, Wilder and Ozgur (2015) define the knowledge domains of BI&A professionals as a combination of business and quantitative disciplines, including project life cycle, data management, analytical techniques, result deployment, and a functional area.

**Research Gaps Identified from the Review**

Based on the review on BI&A education, I found five research gaps:

1. Although studies that investigate the current state of BI&A programs have considered the perspectives from BI&A faculties, current students, and industry practitioners (e.g., Wixom et al., 2014), obtaining feedback from new graduates is another important source to ensure that the expectations and objectives are met. This perspective has not been studied in the existing literature.

2. The research on BI&A pedagogical design and learning activities is mainly exploratory or case study oriented. Theoretical frameworks with empirical or mixed methodologies for assessing the students’ learning effectiveness on the BI&A knowledge and skills are lacking.

3. Although the reviews on BI&A curriculum in the United States are adequate, little is known about the design and development of BI&A curriculum in other countries.

4. Among five research foci, less attention has been paid on the discussions of pedagogical innovations as well as the design of teaching cases related to business analytics courses.

5. An articulated framework of knowledge domains and skill sets for various BI&A professionals is lacking.

**Future Directions For IS Education**

In response to the research gaps and deficiencies of extant research, this paper offers some directions for future IS research. First, in evaluating the state of BI&A programs, it is especially important to consider the perspectives of graduates. Most BI&A programs are undergoing significant transformation on new course development. There has been a debate around how many and what IS/IT-based courses should be included in BI&A curriculum since 2009. Therefore, a longitudinal study to obtain graduates’ opinions at different career stages might provide the evidence of adjustment and improvement of the current curriculum design and meet the industrial demand.

Second, there remains a shortage of theoretical frameworks on how to evaluate students’ learning effectiveness regarding skill acquisition from a BI&A learning activity or course and what antecedents affect student engagement. Future research may borrow and apply the concepts and theories underlying disciplines, such as psychology and sociology, to provide the excellent anchors on studying students’ motivators, behaviors, learning experiences, and learning effectiveness (Wang et al., 2014).

Third, to come up with an articulated framework of skill sets and knowledge domains for BI&A professionals, future research can consider soliciting, via Delphi surveys, the expert opinions from both academics who serve as the chair of business analytics programs or the director of business analytics centers and practitioners who serve as CEO from diverse industries. With a strict Delphi study, such a framework will help organizations adjusting their job selection criteria and thus identifying and
developing qualified analytics professionals as well as providing the foundation of on-job training plan. This will also help educational institutions create a robust business analytics curriculum and thus response to the industrial demands to ensure the success of their graduates.

Fourth, future studies can focus on 1) comparing the curriculum design and pedagogical design between generic IS and BI&A, 2) workforce challenge, and the demand for data scientists’ skills, and 3) benchmarking BI&A programs of different countries (e.g., Singapore, China, and India).

Finally, attaining a high-quality BI&A education is contingent on pedagogical innovations that emphasize fostering students’ problem solving, team work, and communication skills (Wilder and Ozgur 2015). More relevant and practical real-world teaching cases and computer-aided pedagogies (e.g., serious game or free online resources) that teach BI&A concepts or techniques should be presented in the future BI&A research. For example, Teradata University Network (teradtauniversitynetwork.com) is the largest and the most prominent source of BI&A educational resources widely used by the international community of BI&A educators. Future research may study on how to use this source for teaching business analytics concepts to create effective classroom experiences.

**Conclusion**

Based on a hermeneutic literature review related to BI&A education, this study identified the five research foci in the existing literature, and pointed out the research gaps and provided the future directions for each research focus. I found that less attention has been paid on understanding skill sets for various BI&A professionals and demonstrating the BI&A learning activity with the aid of IT among five research foci. Through this review, I hope to raise intense discussions on BI&A education in IS communities and explore theoretical and practical ways to improve teaching in business analytics related courses.

**Reference**


Dinter, B., Goul, M., and Gupta, B. 2012. “Facing the Challenges of "Big Data": Towards Model Curriculum for Business Intelligence in Undergraduate and Graduate IS and MBA Programms,” In Proceeding of the BI Congress 3 Program, Orlando, FL


Marjanovic, O. 2013. “Sharing and Reuse of Innovative Teaching Practices in Emerging Business Analytics Discipline,” In proceedings of 46th Hawaii International Conference on System Sciences (HICSS), Wailea, Maui, HI.


Appendix 1. Papers included in the current analysis (from 2009 to 2015)

<table>
<thead>
<tr>
<th>Author(s)</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>J1 Wilder and Ozgur (2015)</td>
<td>Business analytics curriculum for undergraduate majors</td>
</tr>
<tr>
<td>J3 Chiang et al. (2012)</td>
<td>Business intelligence and analytics education, and program development: A unique opportunity for the information systems discipline</td>
</tr>
<tr>
<td>J4 Dubey and Gunasekaran (2015)</td>
<td>Education and training for successful career in big data and business analytics</td>
</tr>
<tr>
<td>C6 Andoh-Baidoo et al. (2014)</td>
<td>Business intelligence &amp; analytics education: an exploratory study of business &amp; non-business school IS program offerings</td>
</tr>
<tr>
<td>C7 Sharda et al. (2013a)</td>
<td>Business analytics: research and teaching perspectives</td>
</tr>
<tr>
<td>C8 Marjanovic (2013)</td>
<td>Sharing and reuse of innovative teaching practices in emerging business analytics discipline</td>
</tr>
<tr>
<td>C9 Marjanovic (2012)</td>
<td>Using the revised bloom’s taxonomy to scaffold student learning in business intelligence/business analytics</td>
</tr>
<tr>
<td>C10 Yang and Liu (2013)</td>
<td>Teaching business analytics</td>
</tr>
<tr>
<td>J11 Gorman and Klimberg (2014)</td>
<td>Benchmarking academic programs in business analytics</td>
</tr>
<tr>
<td>J12 Edgington (2011)</td>
<td>Introducing text analytics as a graduate business school course</td>
</tr>
<tr>
<td>C13 Erickson et al. (2014)</td>
<td>Building an undergraduate program in business analytics</td>
</tr>
<tr>
<td>C14 Babin et al. (2011)</td>
<td>ERPsim BI: a problem-based learning approach in teaching business analytics</td>
</tr>
<tr>
<td>C15 Bolloju (2014)</td>
<td>Introducing business analytics with a collaborative learning activity using mobile social apps</td>
</tr>
<tr>
<td>J16 Sharda et al. (2013b)</td>
<td>Research and pedagogy in business analytics: opportunities and illustrative examples</td>
</tr>
<tr>
<td>J17 Al-Sakran (2014)</td>
<td>Analysis of business analytics curricula and job demand in Saudi Arabia</td>
</tr>
<tr>
<td>C20 van der Aalst (2014)</td>
<td>Data scientist: the engineer of the future</td>
</tr>
<tr>
<td>J21 Lee et al. (2014)</td>
<td>A cubic framework for the chief data officer: Succeeding in a world of big data</td>
</tr>
<tr>
<td>J22 Gupta et al. (2015)</td>
<td>Business intelligence and big data in higher education: status of a multi-year model curriculum development effort for business school undergraduates, MS graduates, and MBAs</td>
</tr>
<tr>
<td>C23 Marjanovic (2011)</td>
<td>Addressing the ICT-related challenges of business intelligence education</td>
</tr>
<tr>
<td>J24 Sircar (2009)</td>
<td>Business intelligence in the business curriculum</td>
</tr>
<tr>
<td>C25 Zheeng et al. (2014)</td>
<td>Bringing business intelligence to healthcare informatics curriculum: a preliminary investigation</td>
</tr>
<tr>
<td>J26 Mrdalj and Diallo (2010)</td>
<td>Bringing business intelligence into finance curriculum</td>
</tr>
<tr>
<td>J27 Olsen and Cooney (2011)</td>
<td>The business intelligence group: towards collaborative research in a management information systems curriculum</td>
</tr>
<tr>
<td>J28 Wixom et al. (2011)</td>
<td>The current state of business intelligence in academia</td>
</tr>
</tbody>
</table>
C29  Dinter et al. (2012)  
Facing the challenges of “big data”: Towards model curriculum for business intelligence in undergraduate and graduate IS and 
MBA programs

J30  Levine and Stephan (2011)  
Teaching introductory business statistics using the DCOVA framework

J31  Lawler and Molluzzo (2015)  
A Proposed Concentration Curriculum Design for Big Data Analytics for Information Systems Students

J32  Olsen and Bryant (2012)  
Business intelligence and information systems: enhancing student knowledge in database courses

J33  Wixom et al. (2014)  
The Current State of Business Intelligence in Academia: The Arrival of Big Data

J34  Sidorova (2013)  
Business Analysis as an Opportunity for IS Programs in Business Schools

C35  Jacobi et al. (2014)  
Towards a Design Model for Interdisciplinary Information Systems Curriculum Development, as Exemplified by Big Data Analytics Education

J36  Pittarese (2015)  
Teaching business intelligence to computing students through a simulation and evolutionary lab sequence

J37  Presthus and Bygstad (2012)  
Business intelligence in college: A teaching case with real life puzzles

J38  Elizondo et al. (2011)  
Using business analysis software in a business intelligence course

J39  Hosack and Sagers (2015)  
Applied Doctorate in IT: A Case for Designing Data Science Graduate Programs

J40  Liu and Downing (2013)  
Grouping attribute values in a dimensional table design: a customized approach for teaching business analytical applications using Microsoft business intelligence tools

C41  Becker and Dake (2011)  
Job openings in information technology & decision sciences: home brew business intelligence for fun, education and maybe even profit

C42  Pomykalski (2014)  
Teaching Business Intelligence through Case Studies

Design and delivery of technical Module for the business intelligence course

C44  Li et al. (2014)  
Identifying important skill sets to support healthcare data processing and analytics: an empirical examination of perceptions from HIT practitioners.

Note: J=articles appeared in the journals; C= articles appeared in the conference proceedings

Appendix 2. Overview of Prior Related Literature on Business Analytics Education

<table>
<thead>
<tr>
<th>Research focus</th>
<th>Code for Articles</th>
<th>Key Findings</th>
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<tbody>
<tr>
<td>The current state of business analytics education</td>
<td>J2, J3, J16, J22,</td>
<td>• Present an overview of BI&amp;A and the challenges facing IS departments</td>
</tr>
<tr>
<td></td>
<td>J28, J24, J33, C7,</td>
<td>• Report the current state of BI&amp;A regarding its course offerings, the academic alliance programs, and students’ opinions for BI&amp;A courses</td>
</tr>
<tr>
<td></td>
<td>C23, C41</td>
<td>• Investigate the current usage of BI&amp;A software tools for business analytics programs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Speculate on the role of BI&amp;A education in business schools</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Introduce the role of data scientist and CDO and describe their job tasks and responsibilities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Provide the guideline of finding the data scientists and the ways to establish them in practice</td>
</tr>
</tbody>
</table>

The role of data-savvy professional in practice     J19, J21, C20
The design and development of BI&A curriculum

- Propose the BI&A curriculums in the undergraduate and graduate levels
- Review the business analytics programs in terms of their curriculum design and course offerings in the United States
- Address implementation guidelines to build a dream BA program
- Compare the course offerings between business and non-business school

Teaching cases and learning activities

- Demonstrate the teaching cases and pedagogies (e.g., hands-on labs and real life puzzle; cloud computing) for learning business analytics related courses
- Discusses how to engage students in business analytics learning activities

Skill sets and knowledge domains of business analytics professionals

- Identify the skill sets expected for business professional
- Define the knowledge domains of BI&A professionals

### Appendix 3. Skill Sets for BI&A Professionals across four versions

|-------------------|-------------------|----------------------|--------------------------|
| • Communication skills  
• SQL and Query skills  
• Basic analytics  
• Data management  
• Business requirement  
• Data integration  
• Business knowledge  
• Reporting (OLAP) skills  
• Research methods  
• Visualization  
• Advanced analytics  
• Data and text mining  
• Programming  
• Emerging topics  
• No SQL skills  | • Analytical skills (e.g., data mining, deviational analysis and anomaly detection, geospatial and temporal analysis)  
| • IT skills (e.g., relational databases, data warehouse, Hadoop, MapReduce, unstructured data management)  | • Applied statistics (e.g., distributions, sampling statistical inference, linear regression)  | • 1st skill level - data scientist (e.g., a solid foundation in computer science and mathematics)  |  |
| • Business knowledge and communication skills (e.g., understanding business issues listening to what the business needs)  | • Technical skills (e.g., data storage/extraction, SQL, Data warehousing, Hadoop)  | • 2nd skill level – data specialists (e.g., understand how data is managed)  |  |
|  | • Analytical software (e.g., excel, SAS, R, Tableau)  | • 3rd skill level – business analyst (e.g., identify and exploit business opportunities, frame business problems and interpret the results)  |  |
|  | • Soft skills (e.g., communication & presentation, teamwork)  |  |  |